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Selective recovery of valuable metals from an alkaline electronic waste bio-leachate

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Waste electrical and electronic equipment (WEEE), which contains significant concentrations of valuable and base metals, has been identified as the fastest growing waste stream around the globe [1, 2]. Typical leaching processes to extract valuable metals from WEEE are using strong sulfuric acid, hydrochloric acid, nitric acids, aqua regia, and alkalis [3, 4]. In this research, we used less polluted urea to produce ammonia–ammonium solutions for leaching WEEE instead of chemicals added. This process showed a high efficiency in the leaching of copper out of WEEE, but zinc and traces of other elements (e.g., lead, cobalt) that were also recovered into leachate. Therefore, a semi closed-loop system combining electrodeposition, ammonia stripping and crystallization was introduced in this research to selectively recover copper and zinc as well as ammonia from an alkaline WEEE bio-leachate. The target WEEE bio-leachate mainly contained $Cu(NH_3)_4(H_2O)_2^{2+}$ (3.8 g L^{-1}), $Zn(NH_3)_4^{2+}$ (1.3 g L^{-1}), $NH_4{\cdot}H_2O$ (36 g L^{-1}) and $(NH_4)_2CO_3$ (47 g L^{-1}). The removal efficiency of copper in batch (42 h) and continuous (240 h) mode was 99 % and 90 %, respectively. Furthermore, 97 % and 95 % of copper from batch and continuous experiments can be recovered as metallic copper, respectively. Through stripping unit, 81% of ammonia was recovered from batch test and the recovery efficiency of ammonia from continuous mode was 70.8% at a temperature of 60 °C. Zinc was recovered as solid $ZnCO_3$ precipitate in neutral pH through continuous flushing of CO_2 rather than adding acids or bases. 98% of zinc was removed from batch test and removal efficiency of zinc from continuous test was 90%. Our system achieved high recovery and removal of valuable metals and ammonia selectively. At the same time, we also minimized the economic cost and external water input through reusing treated leaching agent for consequent metal leaching and adjusted pH of zinc crystallization with acidic anolyte instead of acids added.

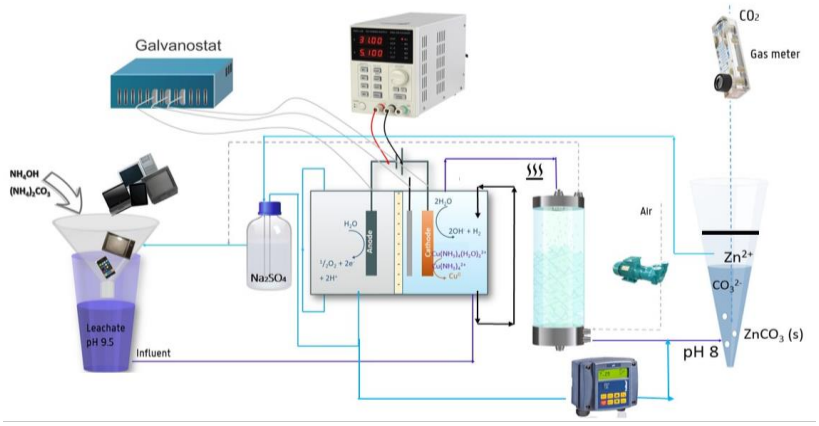

Figure 1. Schematic of the semi closed-loop hydrometallurgical system combining a two-compartment electrochemical cell, gas stripping unit and crystallizer

References:

[1] *Woodhead Publishing Series in Electronic and Optical Materials*, in *Waste Electrical and Electronic Equipment (WEEE) Handbook*, V. Goodship and A. Stevels, Editors. 2012, Woodhead Publishing. p. xxi-xxiv.

[2] Sethurajan, M., et al., *Recent advances on hydrometallurgical recovery of critical and precious elements from end of life electronic wastes - a review.* Critical Reviews in Environmental Science and Technology, 2019. **49**(3): p. 212-275.

[3] He, Y. and Z. Xu, *Recycling gold and copper from waste printed circuit boards using chlorination process.* RSC Advances, 2015. **5**(12): p. 8957-8964.

[4] Sun, Z., et al., *Selective copper recovery from complex mixtures of end-of-life electronic products with ammonia-based solution.* Hydrometallurgy, 2015. **152**: p. 91-99.